Treatment of Important Human Actions Implementation Plan

Revision 3

Non-Proprietary

May 2018

REVISION HISTORY

Revision	Date	Page	Description
0	December 2014	All	First Issue
1	March 2017	vi (Table of Contents)	Appendix B added to TOC. R_315-8091(56R) Appendix C added to TOC. R_510-8650(127)
		4 (3.2)	Terminology changed. (safety analysis -> systems safety engineering) R_250-8282(27)
		7 (3.5.4)	Editorial correction. R_373-8481(97)
		7 (3.5.5)	Description that IHAs included in TIHA ReSR added. R_128-7980(19)
		7 (3.5.6)	Description that IHAs included in TIHA ReSR added. R_128-7980(20)
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		8 (4.1)	Definition of time available modified. R_315-8091(42)
		9 (4.2)	Post LOCA long term phase deleted from exception example of DIHA selection process. R_128-7980(22)
		10 (4.2)	Description for manual action of containment spray deleted R_128-7980(21)
		10, 11 (4.2)	Terminology changed. (safety analysis -> systems safety engineering, safety analysis engineering -> plant operations or systems safety engineering) R_250-8282(27)
		12 (Table 5-1)	Terminology changed. (HSI/I&C -> I&C engineering, safety analysis or plant operations -> plant operations

Revision	Date	Page	Description
			or systems safety engineering) RIHA and DIHA independent review added to TIHA activity. R_250-8282(27)
		13 (6)	Description that TIHA ITAAC included in Tier 1 deleted. R_128-7980(15)
		14 (7)	References about PRA added. R_510-8650(127)
		14 (7)	Reference added. R_250-8282(27)
		B1 (Appendix B)	List of DIHA added. R_315-8091(56R)
		C1-C3 (Appendix C)	List of RIHA added. R_510-8650(127)
		5, 14 (Overall)	Editorial corrections (typos, references)
2	January 2018	4 (3.2) 9, 10, 11, 12 (4.2, 5)	Terminology changed. (Type A → Type A variables) Supplemental description for DIHA extraction added. Editorial correction. (system safety engineering SMEs → systems safety engineering SMEs) 11E47-CR-17-J-220
		8, 10 (4.1, 4.2)	Supplemental description for preliminary TIHA output. R_553-9084(133)
3	May 2018	4 (3.2)	Editorial corrections. (duplicate sentence, typos) R_128-7980(18R)

ABSTRACT

This document is the implementation plan (IP) for the human factors engineering (HFE) of important human actions (TIHA) program element (PE), which is one of 12 PEs in the Advanced Power Reactor 1400 (APR1400) HFE program. This IP governs the technical activities of the TIHA PE by defining the scope methodology output products and the qualifications of the personnel conduct the PE.

The primary purpose of the TIHA PE is to create a list of important human actions (IHAs) and the HFE characteristics assumed for the actions (e.g. stress levels, decision/action complexity, time required). IHAs are used in other APR1400 HFE PEs.

IHAs consist of:

- Risk-important human actions (RIHAs), which are extracted from Chapter 19, Probabilistic Risk Assessment, of the APR1400 Design Control Document (DCD).
- Deterministically important human actions, which are extracted from the defense-in-depth and diversity coping analysis in Chapter 7 of the APR1400 DCD, Instrumentation and Controls; and from Chapter 15, Transient and Accident Analyses, of the APR1400 DCD.

The TIHA IP describes the method of extracting and documenting IHAs. The TIHA IP also provides an overview of how IHAs are addressed in the following other HFE PEs:

- Functional Requirements Analysis and Function Allocation
- Task Analysis
- Staffing and Qualifications
- Procedure Development
- Training Program Development
- Human System Interface Design
- Human Factors Verification and Validation (V&V)
- Design Implementation (DI)

The TIHA is conducted after the human actions (HAs) are identified in the APR1400 PRA, transient and accident analyses, and diversity and defense-in-depth coping analysis. The TIHA is a one-time, nonrecurring HFE PE whose closure is marked by the TIHA results summary report (ReSR).Plant design changes are conducted in accordance with engineering change procedures, which include an evaluation of the IHAs. During the APR1400 design process, the list of IHAs is revised as needed in accordance with the engineering change process; IHA revisions are available for regulatory inspection. After completion of the V&V, site-specific changes, including any required changes to the list of IHAs, are managed within the DI PE, which is a recurring PE for each plant.

Section 1 of this document defines the TIHA purpose; Section 2 establishes the scope, Section 3 provides a methodology overview, Section 4 provides the details of the methodology (implementation) are provided in Section 4, including the format and content of each TIHA output product, and Section 5 establishes the qualification requirements for the TIHA implementation team. Section 6 defines the required content of the TIHA ReSR, which demonstrates that the TIHA PE was conducted in accordance with this IP. Appendix A demonstrates conformance of this IP to the NUREG-0711 review criteria for TIHA.

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ACRONYMS AND ABBREVIATIONS

APR1400	Advanced Power Reactor 1400
BTA	basic task analysis
CCF	common cause failure
COL	combined license
D3CA	diversity and defense-in-depth coping analysis
DCD	design control document
DI	design implementation
DIHA	deterministically identified important human action
DPS	diverse protection system
ESF	engineered safety feature
FA	function allocation
FRA	functional requirements analysis
FSAR	Final Safety Analysis Report
HA	human action
HD	human-system interface design
HED	human engineering discrepancy
HFE	human factors engineering
HEP	human error probability
HP	human performance
HPM	human performance monitoring
HSI	human-system interface
I&C	instrumentation and controls
IEEE	Institute of Electrical and Electronics Engineers
IHA	important human action
IP	implementation plan
ISV	integrated system validation
KEPCO	Korea Electric Power Corporation
KHNP	Korea Hydro & Nuclear Power Co., Ltd.
LBLOCA	large break loss-of-coolant accident
LCS	local control station
MCR	main control room

NRC	U.S. Nuclear Regulatory Commission
OER	operating experience review
PD	procedure development
PE	program element
PPS	plant protection system
PRA	probabilistic risk assessment
ReSR	results summary report
RG	Regulatory Guide
RIHA	risk-important human action
RT	reactor trip
S&Q	staffing and qualifications
SDCV	spatially dedicated continuously visible
SGTR	steam generator tube rupture
SME	subject matter expert
TA	task analysis
TAA	transient and accident analysis
TIHA	treatment of important human actions
TPD	training program development
TS	trade secret
TTA	task timing analysis
V&V	verification and validation

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1. PURPOSE

This document is the implementation plan (IP) for the human factors engineering (HFE) treatment of important human actions (TIHA) program element (PE), one of 12 PEs in the APR1400 HFE program. This IP governs the technical activities in the TIHA PE by defining the scope, methodology, products, and qualifications of the personnel conduct the PE.

The TIHA is performed to create a list of important human actions (IHAs) IHAs, and the HFE characteristics assumed for the actions (e.g., stress levels, decision/action complexity, time required). The IHAs are used in other APR1400 HFE PEs.

- Risk-important human actions (RIHAs), which are extracted from Chapter 19, Probabilistic Risk Assessment, of the APR1400 Design Control Document (DCD) (Reference 4)
- Deterministically identified important human action (DIHAs), which are extracted from the from the APR1400 defense-in-depth and diversity coping analysis (D3CA) in Chapter 7 of the APR1400 DCD, Instrumentation and Controls; and Chapter 15, Transient and Accident Analyses, of the APR1400 DCD

This TIHA IP describes the process for extracting the IHAs from the DCD sources, and the information that is included in that extraction process.

This TIHA IP also provides an overview of how the IHAs identified in the TIHA are addressed in subsequent APR1400 HFE PEs. The details of how IHAs are addressed in the other HFE PEs are described in the IPs of these HFE PEs.

As demonstrated in Appendix A, this IP conforms to the review criteria in Section 7 of NUREG-0711, “Human Factors Engineering Program Review Model.” Rev. 3 (Reference 3). This TIHA IP defines the qualifications of the SMEs required to conduct the TIHA and its independent review. This TIHA IP also defines the required content of the TIHA results summary report (ReSR), which demonstrates that the TIHA was conducted in accordance with this IP.

2. SCOPE

The TIHA encompasses the RIHAs defined by the APR1400 PRA, and the DIHAs defined by the APR1400 TAA and D3CA. Some of the RIHAs identified in the PRA may also be DIHAs identified in the TAA and D3CA.

These APR1400 analyses encompass actions taken by operators from the main control room (MCR) and other plant areas. Abnormal and accident conditions include both normal and degraded human-system interface (HSI) conditions, as defined in the analyses.

3. METHODOLOGY OVERVIEW

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Figure 3-1 Treatment of Important Human Actions Overview

3.1 Risk-Important Human Actions

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3.2 Deterministically-Important Human Actions

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3.3 Independent Review

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[redacted]

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4. IMPLEMENTATION

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4.1 Risk-Important Human Actions

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Table 4-1 TIHA Output for RIHAs

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4.2 Deterministically-Important Human Actions Analyses

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Table 4-2 TIHA Output for DIHAs

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5. IMPLEMENTATION TEAM

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Table 5-1 TIHA Implementation Summary

6. RESULTS SUMMARY REPORT

The results of the TIHA are documented in the ReSR, which demonstrates that the TIHA PE was conducted in accordance with this IP.

The TIHA ReSR includes the following:

- The TIHA results overview, which describes the principal findings of the HFE program element
- Name of each TIHA team member, SME position fulfilled, and the TIHA outputs generated by each team member
- The TIHA execution results, including the following details, which demonstrate conformance with Sections 3 and 4 of this IP:
  - Identified RIHAs, the source of the RIHAs in the PRA, and the HFE characteristics assumed in the PRA
  - Identified DIHAs, the source of the DIHAs in the TAA or D3CA, the HFE characteristics assumed in those analyses, and the basis for concluding any HAs identified in those analyses are not DIHAs
- A conclusion that the TIHA:
  - Has been conducted in accordance with the TIHA IP
  - Demonstrates that the IHAs identified in the TIHA output reflect all of the RIHAs from the PRA and all DIHAs from the TAA and D3CA
  - Has consolidated the IHAs with an adequate level of detail for use in other HFE PEs

The TIHA is a one-time, nonrecurring HFE PE whose closure is marked by the TIHA ReSR. The HSI to support IHAs is ultimately reflected in the APR1400 HSI design, which is tested during V&V. After completion of V&V, site-specific changes, including any required changes to the TIHA output, are managed within the DI PE, which is a recurring PE for each plant.

7. REFERENCES

1. IEEE Std. 497-2002, “IEEE Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations,” Institute of Electrical and Electronics Engineers, 2002.

2. Regulatory Guide 1.97, “Criteria For Accident Monitoring Instrumentation for Nuclear Power Plants,” Rev. 4, U.S. Nuclear Regulatory Commission, June 2006.

3. NUREG-0711, “Human Factors Engineering Program Review Model,” Rev. 3, U.S. Nuclear Regulatory Commission, November 2012.

4. APR1400-K-X-FS-14002, "APR1400 Design Control Document Tier 2,” Rev.2, KHNP, January 2018.

5. APR1400-E-I-NR-14011-P, “Basic Human-System Interface,” Rev. 3, KHNP, May 2018.

6. APR1400-E-I-NR-14001-P, “Human Factors Engineering Program Plan,” Rev. 3, KHNP, May 2018.

7. Full Power Level 1 PRA - Human Reliability Analysis (1-035-N463-105), Rev. 1, KEPCO E&C, April 2015.

8. Low Power and Shutdown PRA - Human Reliability Analysis Notebook (1-035-N463-705), Rev. 0, KEPCO E&C, April 2015.

8. DEFINITIONS

The following terms are used in this document.

Control Lowest decomposition of a success path within the FRA. Control actions are allocated to humans or machine in the FA.

Diagnosis Examination and evaluation of data from the HSI to determine the condition of the plant or the cause of the condition.

Human action Manual response by a member of the plant's operating crew.

Human error Mismatch between a performance demand and the diagnosis or execution of tasks to satisfy the demand.

Human-system interface Alarms, indications, controls, and procedures used by the plant operating crew to monitor the plant, supervise automation, and execute HAs.

Local control station HSI control device that is not located in the main control room or the remote shutdown room; includes single function panels (e.g., controls for a single breaker or valve) and multifunction panels (e.g., controls for a group of plant components) .

Performance-based testing Testing using dynamic simulation and plant operators that includes scenarios targeted to confirm the design of specific HSI features.

Performance-shaping factor Factor that influences HEP, such as availability of procedural guidance and time available to perform an action.

Recovery Restoration actions to transition from an abnormal state to a normal state.

Task Collection of activities with a common purpose, often occurring in temporal proximity, with identifiable start and end points. Control actions are defined and allocated to humans or machine in the FRA/FA PE. HAs are decomposed into tasks, which are analyzed in the TA PE.

Time available Amount of time from the presentation of a cue for HA or equipment response to when adverse consequences will occur if no action is taken.

Time required Time it takes an operator to complete the action that prevents adverse consequences.

APPENDIX-A NUREG-0711, REV. 3, REVIEW CRITERIA CONFORMANCE TABLE

NUREG-0711 Rev. 3 Review Criteria	IP Section
7.4 Review Criteria (1) The applicant should identify risk-important HAs from the PRA/HRA. *Additional Information*: The NRC's technical branch responsible for PRA reviews the acceptability of the applicant's methodology for identifying risk-important human actions. The human factors engineering staff is responsible for ensuring that risk-important HAs included in the HFE design process are the same as those identified in Chapter 19. NRC reviewers should be aware that risk- important HAs may be distributed throughout multiple Chapter 19 tables, a practice that has caused delays in completing reviews.	Subsections 3.1, 4.1
(2) Applicants should identify deterministically important HAs from the following licensing analyses: • operator actions credited in the DCD/FSAR Chapter 15 accident and transient analyses • operator actions identified in the D3 coping analyses performed for DCD/FSAR Chapter 7, as specified in Section 1 and 2 of Interim Staff Guidance DI&C-ISG-02, *Diversity and Defense in Depth (D3) Issues* (NRC, 2009) *Additional Information*: The HFE reviewer should coordinate with the appropriate NRC technical staff to ensure that the operator actions credited in the Chapter 15 accident and transient analysis and D3 coping analyses are correctly identified.	Subsections 3.2, 4.2
(3) The applicant should specify how important HAs are addressed by the HFE program, in Function Allocation, Task Analysis, HSI design, Procedural Development, and Training Program Development, in order to minimize the likelihood of human error and facilitate error-detection and recovery capability. *Additional Information:* The applicant's treatment of important HAs will help ensure that the design supports these actions, and that they are within acceptable human performance capabilities (e.g., within time and workload requirements).	Subsections 3.4.1 3.4.10
(4) Additional Considerations for Reviewing the HFE Aspects of Plant Modifications	Not applicable

APPENDIX-B PRELIMINARY TIHA OUTPUT FOR DIHAs

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The Values of Time Available for All Important Human Actions (IHAs) from Chapter 15

Abbreviations

1. ADV atmospheric dump valve
2. AFW auxiliary feedwater
3. SG steam generator
4. SI safety injection

The Values of Time Available for All Important Human Actions (IHAs) from CCF Coping Analysis **TS**

Abbreviations

1. CIAS containment isolation actuation signal
2. CSAS containment spray actuation signal
3. EDG emergency diesel generator
4. RCP reactor coolant pump
5. SG steam generator

APPENDIX-C PRELIMINARY TIHA OUTPUT FOR RIHAs

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Table 1. Risk-Important Human Actions (RIHAs) at Power from Chapter 19

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Table 2. Risk-Important Human Actions (RIHAs) at LPSD from Chapter 19

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